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Market
Analysis and
Planning
Services
(MAPS)

**U.S. Information
Services
Industry-Specific
Markets
1987-1992**

Discrete
Manufacturing
Sector

INPUT®

U.S. INFORMATION SERVICES INDUSTRY-SPECIFIC MARKETS, 1987-1992

DISCRETE MANUFACTURING

INPUT

**Market Analysis and Planning Services
(MAPS)**

*U.S. Information Services Industry-Specific
Markets, 1987-1992
Discrete Manufacturing*

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Exhibits

I

Issues, Trends, and Events

I

Issues, Trends, and Events

This section discusses issues, trends, and events that affect or impact the manufacturing sector. Primarily, American manufacturers have a major concern about improving productivity to become more competitive in domestic and worldwide markets.

This concern is complicated by a complex economic environment. The very large U.S. balance of trade, a negative $151 billion in 1986, possible tax increases in 1988, the potential for protectionist legislation in Congress, the need to reduce the U.S. budget deficit in 1988 and beyond, and the potential for a 1988 recession if consumer spending slows are all uncertainties that complicate the manufacturing outlook.

The long-term growth trends are still moving upward, but at a steadily decreasing rate. Total U.S. manufacturing shipments will grow only 2% from 1986 to 1987. However, the discrete manufacturing industry is the second largest market sector in terms of information systems spending and represents a significant opportunity for many vendors.

A

Productivity

The U.S. manufacturing sector is steadily losing market share to imported products. Nearly two-thirds of near-term growth in U.S. markets will be claimed by imports. Although the rapidly falling dollar may make U.S. imports more competitive, this is no guarantee of success as barriers to entry must be overcome.

Investment in information systems will increase by 16% during the 1987-1992 period, with food, computer, and electronics segments being most aggressive. Most large manufacturers have already invested in manufac-

turing planning and control systems (MPCS), which have become a
mature market at the high end.

Investment in computer-aided manufacturing (CAM), design (CAD),
engineering (CAE), and maintenance (CAMM) tools is a newer market
and growing more rapidly.

The widespread recognition that company-wide automation systems are
necessary for economic survival has been accepted as gospel by most
large manufacturers and more and more smaller firms are recognizing
this also. This trend has been generally identified with the phrase "com-
puter-integrated manufacturing."

B
Computer-Integrated Manufacturing (CIM)

CIM is defined as the integration of separately automated factory func-
tions, including MRP II, CAD/CAM/CAE, DSS, robotics, ATE and
more. It is important to recognize that CIM is a process and a philosophy,
not an event. Neither is it a panacea, as implementation will take time,
money, commitment, expertise and patience.

There are major barriers to CIM:

• lack of technical knowledge and understanding.
• lack of management support.
• resistance to change.
• cost justification.

These barriers will not be removed easily.

General Motors has made a $40 billion commitment to CIM, and has
been a prime mover in the evolution of MAP (see next section). Ford
Motor Company is soon to make a company-wide major investment.
Boeing has embraced the concept and has begun planning for large-scale
implementation. Other very large companies are also involved deeply.
Forecasts of CIM expenditures project $100 billion by 1992. While an
exact timetable is difficult to forecast, the potential is there.

Declining costs of microprocessors, and their dramatically increased
power, will propel smaller companies into CIM. This may serve to offset
any resistance to implementing large-scale systems at very high cost.

C

MAP (Manufacturing Applications Protocol)

MAP is a tool with which to build a foundation for CIM, providing a series of protocols for connecting mixed vendor hardware/software systems.

General Motors sponsorship and involvement have driven MAP, and pilot projects are now in place using MAP versions 2.1 and 2.2. Full implementation systems are possible with version 3.0, a "production" version available in 1988. Enhanced performance architecture will help computer-intensive applications and minimap will provide greater speed and better response times in certain network configurations. But complete multi-level MAP protocols and standards are still three or four years away, at least.

A new General Motors study has shown that MAP-based systems are less expensive to install than those using proprietary protocols. In the study, a MAP system cost $3,000 per mode, compared with $2,664 per mode for proprietary systems. However, when software and training costs are added, MAP was 40% less expensive.

MAP is best suited for environments which are characterized by:

- complex manufacturing operations.
- multiple systems utilization.
- data input received from computer sensors and counters on the assembly line.
- multiple vendors' software/hardware in use.
- MRP II is installed to meet present or future competition.

Forty percent of manufacturing companies responding to a recent survey indicated they expect MAP to be affordable and viable in 1990.

Like CIM, MAP must be considered a multi-year process, not an event. Both vendors and users must understand this.

From a vendor standpoint, MAP will require a major commitment, but sitting on the sidelines and waiting may result in a serious competitive risk. Vendors who are not serious about CIM should not start on MAP.

Several vendors have moved aggressively to position themselves for MAP implementation as an industry standard:

- Connectivity for MAP/TOP protocols is offered by DEC, IBM, Sun and other equipment manufacturers.

- EDS will emerge as a major participant, because of their role as GM's systems integrator for MAP.

- Sytek offers broadband networks, a necessity for MAP systems.

- General Electric has introduced GE NET.

- Concord Data Systems is assisting EDS in the GM implementation.

- Allen-Bradley introduced its Data Highway.

D

Absorption

Absorption is currently a major issue, although it is not always recognized as such. Absorption, in this case, means that the rate of introduction and amount of product available has reached a point where it is well ahead of the user's ability to "absorb" or implement new products.

- Absorption applies directly in the software area and it partially accounts for the decline in the growth rate for software vendors.

- Absorption is not as much of a problem in the discrete manufacturing sector as in other sectors due to IS management's continuing insistence on customized solutions.

This phenomenon also is contributing to the lengthening of the decision cycle, since more products to evaluate result in absorbing more staff resources. To compound the problem, the rate of new product introductions has IS managers even more confused.

- Yet another factor contributing to these delays is the increasing complexity resulting from planning for integrated environments. This complexity will continue to cause delays in the decision process, but is also a professional services opportunity, to assist manufacturing firms in planning and implementing complex systems.

- This is very difficult for turnkey systems vendors, as their systems become more complex and the cost of sales goes up when the sales cycle stretches out.

While absorption may be fully appreciated by the user community, it is an issue that vendors should analyze carefully in terms of each of their market segments.

E

IBM's Position

As in other large markets, IBM is and will be a factor. IBM is the leading supplier of MRP II systems, in market share. In discrete manufacturing, IBM's strategy is expected to be similar to its general strategy, which is to maintain centralized systems. There are a few specific moves relative to manufacturing systems.

- IBM has slowly but surely put a short-term strategy in place. Included for the short term are products for computer-aided design, industrial robots, shop floor microcomputers, and specialized workstations. These products will be sold to the islands of automation, but will not connect them.

- IBM's longer term strategy is to tie these components together with an architecture based around data base management systems on the mainframe – more of the same centralized structure that INPUT has predicted for IBM throughout the 1980s.

- Although IBM has announced MAPICS II implementation for the System 36 and the System 38, it does not appear this was for a departmental strategy, but rather for the low-end market.

- A clear indication of IBM's commitment to this market is the special business units (the same tactic used to launch the PC) established last year to address CAD and robotics.

IBM recently launched their Applications Systems Division, with several thousand employees dedicated to improving IBM's position in industry-specific software markets. If IBM chooses to address discrete manufacturing, as is likely, they will make a significant impact.

IBM can be expected to follow the overall strategy predicted by INPUT in the late seventies. This strategy consists of introducing, in the early 1990s, decentralized architectures to address office automation and departmental computing. In the meantime, IBM will participate and confuse the market where and when necessary in order to fend off any perceived competitive threats.

Despite IBM's commitment, they may not be the lead vendor in implementing complex manufacturing systems in the late 1980s and 1990s. These systems will involve multiple subcontractors and somewhere a lead "contractor" or system integrator will emerge.

F

MRP II: A Crowded Market

MRP II systems are now offered by over 300 vendors, many of them using micro-based systems. There are only 2,000 U.S. firms large enough to spend $1-2 million for mainframe-based systems, and this market segment is 70% saturated. At the high end, replacements and upgrades are the primary opportunity.

Penetration of small and mid-sized firms is more likely now, as declining costs bring these systems into affordable ranges. Price declines are likely to be spurred by microprocessors. In 1985, the average MRP II purchase price was $375,000. By 1990 the price will be $250,000

EXHIBIT I-1

ISSUES AND IMPLICATIONS

AREA	ISSUE	IMPLICATIONS FOR I.S. VENDORS
Markets	• Declining share of world-wide markets • Major deficit in U.S. merchandise trade balance • Heavy competition from "lower-cost" foreign firms	• Increased interest in improving production efficiencies
	• Need for company-wide automation strategies	• More rapid obsolescence of older automated systems • More frequent company-wide systems contracts with vendors • Systems integration approach
	• Need for increased inter-departmental planning and coordination	• Need for more education and training services • Professional services opportunities

EXHIBIT I-2

ISSUES AND IMPLICATIONS
(Cont.)

AREA	ISSUE	IMPLICATIONS FOR I.S. VENDORS
Production	• Interest in "just-in-time" manufacturing - Reduced inventory - Flexible set-up - Improved material handling - Instant Communication	• Less complex MRP II planning units • Relational DBMS and group technology • Improved automatic storage and retrieval systems • Physical linkage of shop floor and engineering systems via telecommunications • Factory floor LANs + office LANs • Standardization of network protocols (e.g., MAP) • Need for electronic information interchanges between suppliers, manufacturers, and dealers.

II

Market Analysis and Forecast

II
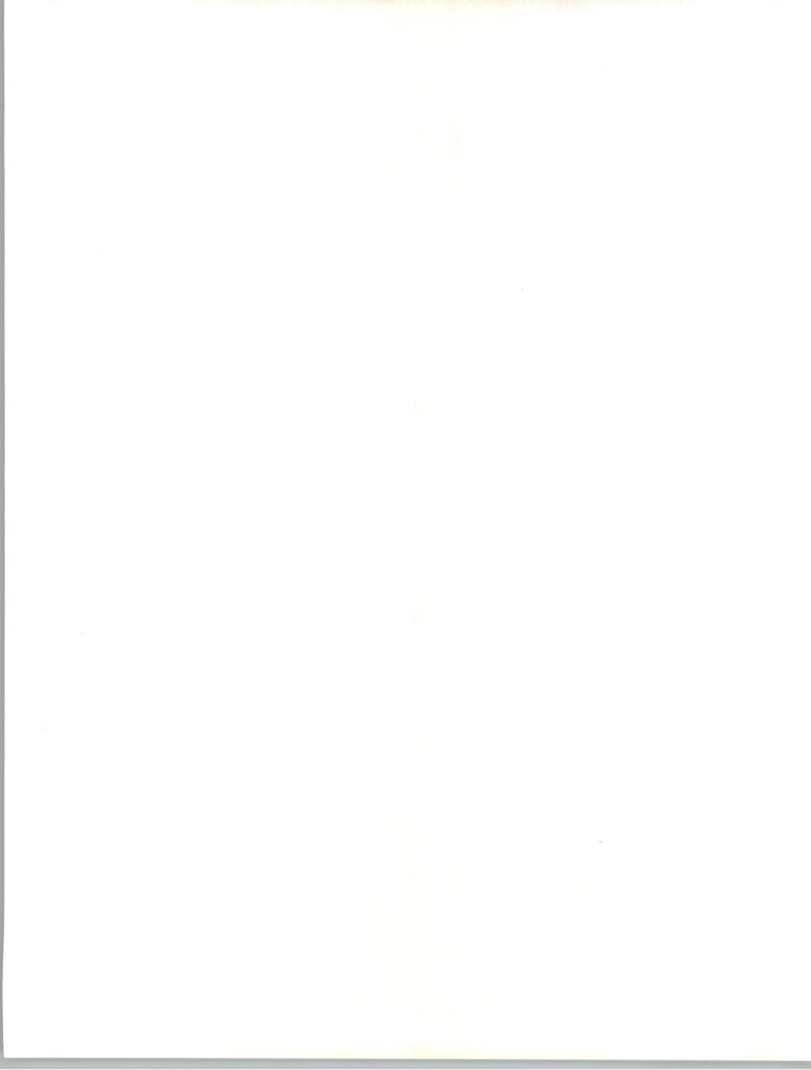
Market Analysis and Forecast

INPUT has segregated the discrete manufacturing industry sector as follows:

Manufacturing Planning and Control Systems (MPCS)

- Customer order processing
- Sales forecasting
- Capacity planning
- Master production scheduling
- Material requirements planning (MRP)
- Manufacturing resource planning (MRP II)
- Bill of materials processor
- Inventory management/control/JiT
- Product costing/routing
- Job costing/labor control
- Shop floor control
- Manufacturing standards/costing/engineering
- Purchasing

Design and Fabrication Systems

- Computer-Aided Design (CAD)
- Computer-Aided Engineering (CAE)
- Computer-Aided Manufacturing (CAM)
- Computer-Aided Manufacturing Maintenance (CAMM)
- Numerical Control Machines
- Robotics

Professional Services

• Consulting, education, training, support, software customization, systems integration.

Based on this segmentation, INPUT developed the following forecast data.

A

Total Industry-Specific Spending

The overall performance of the discrete manufacturing sector is expected to grow 21% in 1987, from $5.2 billion in 1986 to $6.4 billion in 1987.

The outlook for continued growth is at a slightly lower rate, 16%, during the 1987-1992 period. Revenues will reach $13.5 billion in 1992, as shown in Exhibit II-1.

Professional services growth is projected at 21%, reflecting the complexity of implementing CIM, MAP, MRP II, and CAD/CAE systems. Significant investment is required in consulting, training, planning, software customization and systems integration to install many of these systems.

By 1992, professional services revenues will equal combined revenues from processing services, applications software, and turnkey systems. Even 1986 professional services generated more revenue than any single product delivery mode category.

Processing Services (remote computing, batch processing, and facilities management) will grow at a 12% rate from $785 million in 1987 to $1.4 billion in 1992.

Applications software is the fastest growing product segment, at 17%, from $1.2 billion in 1987 to $2.5 billion in 1992. Within applications software, microprocessor software growth is 25%; mainframe/mini software grows at a 15% rate, reflecting the high-end market saturation described earlier. Exhibit II-2 shows this data graphically.

Turnkey systems are also subject to the saturation factor, as well as declining equipment costs. Turnkey systems generated $1.9 billion in 1987, and will grow at 10%, to $3.0 billion in 1992. Turnkey systems are, and will remain the product delivery mode producing the largest revenues.

EXHIBIT II-1

**DISCRETE MANUFACTURING SECTOR
TOTAL USER EXPENDITURES, 1987-1992**

User Expenditures
($ Milions)

1987-1992 AAGR	Professional Services	Turnkey Systems	Applications Software	Processing/ Network Services	Total Industry Revenues
1987	2587	1861	1181	785	6414
1992	6593	2997	2522	1386	13528
1987-1992 AAGR	21%	10%	17%	12%	16%
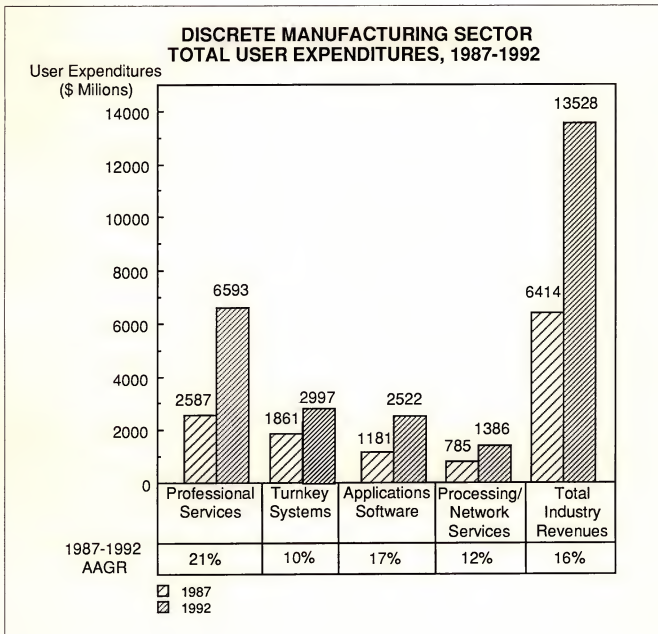
☒ 1987
☒ 1992

EXHIBIT II-2

DISCRETE MANUFACTURING SECTOR
USER EXPENDITURES
BY DELIVERY MODE, 1987-1992

User Expenditures
($ Millions)

1987-1992 AAGR	Remote/ Batch Computing	Facilities Manage- ment	Mainframe and Mini	Micro
	Processing/ Network Services		Applications Software	
	12%	13%	15%	25%

Values shown on chart:
- Remote/Batch Computing: 726 (1987), 1,279 (1992)
- Facilities Management: 59 (1987), 107 (1992)
- Mainframe and Mini: 1,011 (1987), 2,033 (1992)
- Micro: 170 (1987), 519 (1992)

1987

1992

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B

Product-Specific
Expenditures

1. Manufacturing Planning and Control Systems (MPCS)

MPCS markets have reached a mature state, and will grow at a 10% rate during 1987-1992, from $1.7 billion to $2.7 billion, as shown in Exhibit II-3.

There are over 268,000 manufacturing companies in the U.S., but only 2,000 can afford CIM and MAP-type fully-integrated systems. As many as 230,000 of these firms are potential candidates to implement microprocessor-based MRP II systems. Only 5% of these companies are currently using MRP II; by 1990 as many as 50% may be. This is a net increase of more than 100,000 MRP installations. Most of these will be standalone systems, not tied to mainframes, at least at first. Potential for EDI and MAP connectivity will be high in the mid-1990s when these systems begin to mature.

There are over 200 micro-based MRP II vendors now in the market. A shake-out seems likely.

Market share of MRP II sites is dominated by IBM, followed by MSA/ Comserv, Martin Marietta, ASK/NCA, and Cullinet.

In the mid-range IBM Systems 36/38 market, IBM has captured 38% of the business with MAPICS and MAPICS II. These are typically purchased by first time users, who may upgrade later.

Worldwide, there are more than 29,000 MRP sites. IBM and the "first tier" ten major suppliers have over 60% of this market. Exhibit II-4 reflects market share of MRP II installations in the U.S.

MRP II has recently been criticized by the Defense Contracting Administration Agency (DCAA) as being not reliable for government contracting costing and payment purposes. The controversy is still unresolved, but may complicate matters for software vendors selling to the aerospace industry.

EXHIBIT II-3

DISCRETE MANUFACTURING SECTOR USER EXPENDITURES FORECAST BY PRODUCT-SPECIFIC CATEGORIES

User Expenditures
($ Billions)

Total Product
Segment AAGR = 13%*

	Management Planning and Control	CAD/CAE/ CAM/CAMM
1987	1.7	2.1
1992	2.7	4.2
1987-1992 AAGR	10%	15%

☑ 1987 ☑ 1992
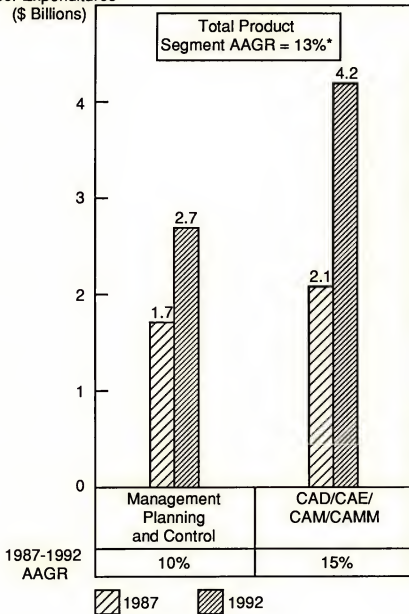
*Without Professional Services.

EXHIBIT II-4

MARKET SHARE: U.S. MRP II SITES
(Percent)

Vendor	Percent
IBM	31
MSA/Comserv	21
Martin Marietta	17
Ask/NCA	13
All Other Vendors	10
SSA	6
Cullinet	2

(Scale: 0 10 20 30 40%)
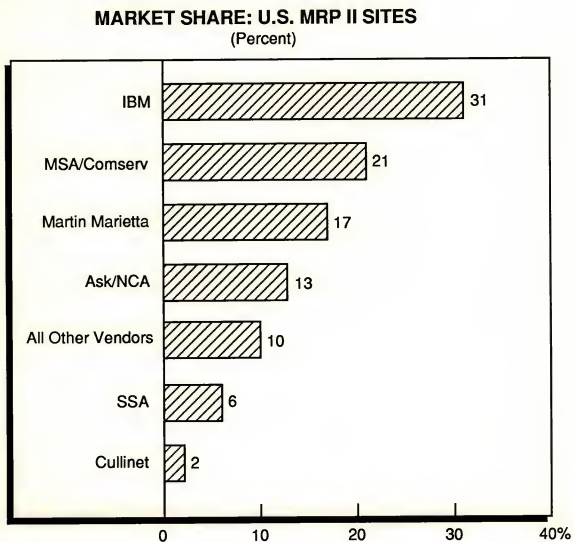
2. CAD/CAE/CAM

Automated design and fabrication operations are less mature markets
than MPCS, and are growing more rapidly. With a forecast 15% growth
rate, these systems will produce $2.1 billion in 1987, doubling to $4.2
billion in 1992.

Aerospace manufacturing companies are the largest users of this technol-
ogy. While $49 million was spent on aerospace CAD/CAE/CAM activity
during 1984, this will grow to $300 million by 1989.

Electronics and transportation manufacturing firms are also investing
heavily in these technologies.

CAD/CAE/CAM systems are often delivered as standalone workstations,
although mainframe-oriented systems are still abundant. Major vendors
such as Sun, Digital, Intergraph, and Hewlett-Packard are investing in
more powerful workstations, some with Reduced Instruction Set Comput-
ing Architecture (RISC) to improve their competitiveness.

Leading suppliers in this sector include:

- IBM
- Computervision
- Intergraph
- Applicon
- Auto-trol
- McDonnell Douglas
- Gerber Scientific
- Calma
- Autodesk

OEM deliveries of CAD/CAE/CAM systems are common. Workstations
from Apollo and Sun have leading equipment positions, coupled with
applications software from OEMs and VARs. Today, software represents
about 30% of the price of a turnkey workstation. By 1992, declining
equipment prices and greater software complexity will raise that figure to
50%.

Microprocessor-based systems are entering the market, and competition
is heavy. These low-cost systems directly contributed to lost market share
at Computervision and Auto-trol, and a number of start-up companies

have been closed after failing to achieve sufficient market penetration to insure profitability.

A key competitive factor will be the ability to integrate data and graphics from CAD/CAE workstations with shop floor computers, and shorten lead times between design and production. Vendors who are able to demonstrate and perform this integration will have a marketing advantage over those who cannot.

Another trend is broader distribution of CAD/CAE functions. Rather than be tied to a single workstation, newer, more powerful systems can support a number of separate "seats" at technical workstations, tied together in a network.

Flexible manufacturing systems (FMS) are able to manage as many as eight numerically controlled machine tools from a single location. These are mainly provided by machine tool companies and sold into the metal-working industry.

Most user investments in these systems, as much as 75%, are a part of a desire to reduce labor costs. This will be an increasingly difficult task, because U.S.-produced goods now have a direct labor content of only 10-15% of their overall cost. Attention must be paid to indirect labor, materials cost, transportation, and distribution costs as well.

3. Professional Services

The fastest-growing segment in information systems for discrete manufacturers is professional services. From $2.6 billion spent in 1987, this segment grows to $6.6 billion in 1992, a 21% growth rate. At that level, professional services is as large as the combined revenues from processing/network services, application software, and turnkey systems.

The opportunities in professional services are created by the complexity of the systems needed and an industry preference for customized systems. The classic "systems integrator" role is one that can be performed effectively for many larger manufacturers.

Arthur Andersen, with its large staff of professional consultants, has assumed a leading role; there is ample room for many other participants. Arthur Andersen's presence is complicated, and also enhanced, by the fact that it sells an MRP II system (MAC PAC) as well as offers consult-

ing services. This makes Arthur Andersen unique among the "Big 8" and other major consulting companies. There are now over 200 MAC PAC installations in the U.S.

Tandem Computers has formed alliances with Arthur Young and Coopers and Lybrand in delivering manufacturing systems and services.

Vendors who are positioned to assume a leading consulting role in this industry, beside Arthur Andersen and the other "Big 8" accounting firms, include EDS, Computer Task Group, Systems Control, and Keane Associates.

Companies who have developed systems integration skills and experience while executing complex federal government contracts may also find their expertise can be translated to the discrete manufacturing sector. Many CIM and MAP projects of greater complexity are likely to be conducted using the same systems integration philosophy.

III

Competitive Developments

III

Competitive Developments

A

Market Structure

The market share of selected leading vendors is shown in Exhibit III-1. Since some organizations are not willing to release revenue data by industry sector, the list is not complete, but is representative.

1. Manufacturing Planning and Control Systems (MPCS)

IBM is the dominant vendor, in delivering MAPICS II and COPICS (applications solutions).

Software products as a delivery mode has attracted the most vendors. This is due partially to user demand and partially to vendor assessments of the market. Systems software vendors like Cullinet and Cincom are seeking to leverage their presence in these markets by launching applications software based on their tools, while others like MSA leverage their experience with other applications software products. MSA has further strengthened its role through the acquisition of Comserv.

Processing/network services leaders are McDonnell Douglas Information Systems Group, Boeing Computer Services, GEISCO, and Xerox Computer Services.

ASK is the turnkey systems leader, and has improved its position with the recent acquisition of NCA.

Large hardware manufacturers IBM, DEC, Unisys, Hewlett-Packard and others, will provide competition, but are primarily interested in leveraging sales of their equipment. Information services vendors should consider and pursue strategic alliances with these firms, especially for large opportunities.

EXHIBIT III-1

MARKET SHARE OF INFORMATION SERVICES VENDORS
DISCRETE MANUFACTURING SECTOR, 1987

VENDOR NAME	1987 REVENUES ($ Millions, U.S. Sales)					
	Processing & Network Services	Applications Software Products	Turnkey Systems	Professional Services	Total	Share of Market (Percent)
IBM	12	310	-	-	322	5.0
McDonnell Douglas I.S.	10	-	160	10	180	2.8
Calma	-	25	110	-	135	2.1
Arthur Anderson	-	60	-	66	126	4.0
Computervision	-	30	60	30	120	1.9
Gerber	-	-	115	-	115	1.8
ASK (& NCA)	10	15	82	3	110	1.7
Applicon	18	9	72	-	99	1.5
Boeing Computer Services	90	-	-	-	90	1.4
Control Data Corp.	-	-	62	-	62	1.0
MSA (& Comserv)	-	38	-	15	53	0.8
Intergraph	-	-	50	-	50	0.8
EDS	25	-	20	-	45	0.7
Cullinet	-	45	-	-	45	0.7
GEISCO	42	-	-	-	42	0.7
Xerox Computer Services	20	10	10	-	40	0.6
American Software	-	27	-	9	36	0.6
Martin Marietta D.S.	14	8	-	-	22	0.3
DEC	-	20	-	-	20	0.3
Dun & Bradstreet (Must Software)	-	20	-	-	20	0.3
Systems Software Assoc.	-	21	-	-	21	0.3
Cincom	-	16	-	-	16	0.2
Hewlett-Packard	-	16	-	-	16	0.2
Autodesk	-	-	10	-	10	0.2
Keane, Inc.	-	-	-	10	10	0.2
Sub-Total	241 (31%)	670 (57%)	751 (40%)	143 (6%)	1805 (28%)	
All Other Vendors	544	511	1110	2444	4609	
Total Market	785	1181	1861	2587	6414	

Systems integration, long a practice in federal government procurement activity, is a discipline whose time has come as a procurement strategy for complex systems in discrete manufacturing.

While IBM does have a significant position in this sector, INPUT believes IBM's current strategy of centralizing information processing on large host computers provides a window of opportunity for competitors.

- Manufacturing is currently one of the more decentralized industry sectors, and it appears firms are willing to continue to embrace decentralized solutions.

- INPUT further believes that IBM will not move aggressively into decentralized systems, based on the premise that the manufacturing sector will not find adequate solutions from competitors in the near term.

The strong showing of the turnkey vendors in the market is evidence of the "islands of automation." These vendors are predominantly suppliers of CAD/CAM systems and are expected to maintain their presence and, through alliances such as GE Calma, be able to expand in the emerging CIM market.

2. CAD/CAM/CAE

The size and growth of the CAD/CAM/CAE market has attracted many vendors. However, it is not as fragmented as the manufacturing control segment. The participants can be grouped in the following four categories:

- Hardware (processors, digitizers, plotters, interface boards, controllers, and other peripherals) from vendors like IBM, DEC, HP, Tektronix, CDC, Perkin-Elmer, Apollo, and Sun Microsystems.

- Software (graphics operating systems, image processing, animation, and application-specific products) from Applicon, Cadam, Grafcon, and others.

- Turnkey systems (complete hardware and software applications systems for design, layout, and other applications) from Auto-trol, Intergraph, ComputerVision, GE Calma, IBM, and others.

- Processing/network services (application-specific service products) from McDonnell Douglas, CompuServe, CDC, Dun & Bradstreet, and others.

The highly structured nature of CAD/CAM/CAE applications creates the necessity for structured applications highly focused on the end-user requirement, thus making room for vendors who truly understand the market at a detailed application level.

The supermicro and, to a lesser extent, micro-based products are creating confusion in this segment due to the very low price systems these products allow.

The CAD and CAM areas are still growth markets, but the emphasis for the future will be integrating CAD and CAM with other systems including:

- Programmable controllers.
- Shop floor control.
- Quality control.
- Planning.
- Numerical control.

The CAMM application system involves computer-based analysis and scheduling of maintenance. This is a most valuable tool and is primarily used for scheduling preventive maintenance. The next step is predictive maintenance that allows the system to analyze the machines and predict when failures are about to occur.

The CAMM system consists of three major components:

- Machine and production monitoring.
- Maintenance dispatch.
- Preventive maintenance.

B

Profiles of Thirteen Leading Competitors

1. IBM

a. Products/Services

MAPICS, COPICS, many third-party applications. COPICS is in use in 500 mainframe sites; over 10,000 MAPICS installations dominate the System 36/38 market, with a 38% market share.

b. Markets Served

Discrete manufacturing companies using IBM mid-range and large systems. Also, IBM's personal computers will be used extensively to extend market reach and depth.

c. Company Strategy

IBM's strength centers around the widespread use of its hardware combined with the strength of its name recognition and support capabilities. In addition, IBM has the additional advantage of being able to integrate hardware and software at the point of sale. IBM can price software low in order to promote hardware sales while still being able to support continued product improvements with lower R&D costs as a percentage of total sales.

IBM's commitment to application software is demonstrated by its formation of the Applications Systems Division, with several thousand employees dedicated to the production and marketing of vertical market software, for specific, still unidentified large niche markets.

d. Recent Activities

IBM has not made public any significant activity in the areas of computer-integrated manufacturing (CIM) or in the integration of its traditional manufacturing software with CAD/CAM applications. However, IBM is moving behind the scenes in efforts like licensing AML, a manufacturing language, to machine tool vendors such as Cincinnati Milacron.

IBM's current compensation plan strongly urges its sales people to sell MAPICS software along with System 36/38 computers. This is a change from prior plans.

e. Future Directions

IBM will move quickly to increase penetration of this sector in order to expand its presence now and leverage that presence in development of the CIM market. IBM will use its control of the corporate data base to gain control of factory systems through a "data integrity" strategy.

2. DEC

a. Products/Services

VMCS, FDCM, PMCS.

b. Markets Served

Large discrete manufacturing companies using VAX-11 and PDP-11 with RSX-11 and VMS operating systems.

c. Company Strategy

Like IBM, DEC's strength is based on widespread use of their hardware, especially in industrial environments. DEC has been very strong in manufacturing, communications and government applications. DEC has a worldwide software support and training operation and provides services in 47 countries.

d. Recent Activities

DEC has been emphasizing relationships with third-party application developers as well as developing new OEMs with machine tool and automated materials handling vendors such as GE/FANUC.

e. Future Directions

DEC will seek to develop allies in the non-computer technology segments and to leverage its existing strengths on the factory floor and with OEMs. DEC will also seek alliances with potential large-scale systems integrators.

3. Cullinet

a. Products /Services

Cullinet Manufacturing System.

b. Markets Served

Medium to large discrete and process manufacturing firms using IBM and plug-compatible mainframes and DEC VAX mini-based systems.

c. Company Strategy

Cullinet entered the manufacturing software market in 1980 by purchasing a manufacturing system from Rath and Strong. Prior to 1981, Cullinet (then known as Cullinane Data Base Systems) made a name for itself in data base development. Cullinet stresses the advantages of its MRP II software offering, utilizing the highly regarded IDMS/R relational data base. While competitors tend to point out Cullinet's relative inexperience in manufacturing, Cullinet counters that a truly integrated manufacturing solution revolves around the data base and that its competitors' MRP II products utilize revamped 1970s technology in data base design. As a result, Cullinet tends to attract IS managers who like Cullinet's reputation, particularly in the area of data base design.

d. Recent Activities

A recent shakeup at Cullinet reflects a desire to strengthen its image in manufacturing. Cullinet brought in former Data General executive David Chapman as Vice Chairman and Chief Executive Officer, prompting President Robert N. Goldman (one of Cullinet's original ten employees) to resign. Chapman's last position with Data General was Senior Vice President for manufacturing, and this move should signal increased attention to technological development into the manufacturing processes.

Cullinet will push its 4GL solution, (ADS/0), tied to its IDMS/R relational data base.

Cullinet ranks high in industry surveys, due to well-satisfied customers.

Cullinet recently released its "Repetition" closed loop software, for volume-oriented production/inventory control applications.

C-TRAK is an MRP II system for government contractors to report to the federal government.

e. Future Directions

After 21 consecutive quarters of growth in the 50% range, Cullinet slumped in 1986 and 1987. Cullinet is apparently recognizing the stagnancy of the cross-industry market and instead will concentrate on enhancing its manufacturing software. Specifically, Cullinet will increase activity in the areas of repetitive manufacturing processes and in integration of CAD/CAM and CIM applications.

4. ASK Computer Systems, Inc.

a. Products/Services

MANMAN Information System, available as a turnkey system, as a software package, or as RCS processing services.

b. Markets Served

Discrete and process manufacturing firms. Smaller companies (less than $10 million) are targeted with the RCS offering. Larger companies ($10 - $200 million) that currently have DEC VAX or HP 3000 systems are targeted with the software offering. ASK recently cancelled plans to offer a package for IBM 4300 small mainframes.

c. Company Strategy

After targeting the HP 3000 market exclusively, MANMAN sales for VAX systems have equalled MANMAN/3000 (for HP 3000 systems) in 1987. With the Micro VAX II offering, ASK will compete for smaller ($1 - $10 million) manufacturers with such vendors as MDS Qantel.

d. Recent Activities

ASK has announced its intention to link MRP with automated test equipment and to develop a transaction-oriented data base management system. Its acquisition of NCA expands ASK's customer base by 50% to 2,000 users.

e. Future Directions

ASK/NCA will form a powerful marketing force, and secure ASK's position as a leader in the turnkey systems area.

5. Xerox Computer Services

a. Products/Services

Xerox Manufacturing System.

b. Markets Served

Discrete manufacturing companies with IBM 4300, 370, 303X, or 308X mainframe systems. Also, Xerox targets smaller, decentralized, and transitional manufacturing companies with its RCS manufacturing system. Xerox also markets a turnkey manufacturing product called the Xerox Business Management System (XBMS) for customers as small as $10 million in annual sales and a turnkey system for companies with revenues of $40 million and up called the Entry Turnkey System.

c. Company Strategy

In 1982 approximately 90% of XCS total computer service revenues were derived from processing services, with just under 10% from software products and only a fraction of a percentage coming from turnkey systems. Since then, the costs of acquiring computing power have come down to a level that has enabled many companies to bring processing in-house. Software and turnkey sales, particularly in the manufacturing market, now account for over 30% of XCS' annual revenues and XCS has delivered XMS to more than 200 clients. While Xerox is certainly emphasizing manufacturing software sales, they are by no means abandoning their RCS business. XCS stresses the advantages of RCS processing for those large manufacturers with widely dispersed operating locations, due to XCS' networking expertise and the increased phone rates and difficulty in dealing with multiple phone companies since the breakup of AT&T. Other prime candidates for RCS manufacturing processing are startup companies who have not yet decided on their own data processing strategies. Thus, XCS steps in on an interim basis, providing both the industry-specific expertise and the data processing experience.

d. Recent Activities

The major share of recent developments by XCS is in the software area, specifically in introducing or improving specific modules for its integrated manufacturing software products. Within the last year, XCS has introduced a number of new modules, including a repetitive manufacturing module for its Xerox Business Management System. Xerox also expanded its CAD systems line by introducing its Xerox Professional Mechanical Systems, an Ethernet-linked LAN of workstations that share common data bases.

e. Future Directions

XCS has made public two specific goals for the future: first, to concentrate on accessing an enormous potential market of small- to medium-sized manufacturing companies and automating their factories' work floor; second, to place greater emphasis on moving toward computer-integrated manufacturing with much greater integration with CAD and MRP applications.

Further, XCS has targeted Cullinet as its chief competitor in the market and should continue to make improvements and enhancements in its own package to compete with Cullinet's Manufacturing System, particularly in the database management area.

6. EDS

a. Products/Services

Professional services and facilities management.

b. Markets Served

EDS' association as part of General Motors stimulated efforts to actively pursue improvement of the manufacturing process. EDS has been spear-heading the efforts of American manufacturers to force hardware vendors to implement MAP on their systems. Now it has gone one step further by designing and testing MAP at GM's plants.

c. Company Strategy

While EDS is working to put MAP on the factory floor, it is also building the large, complex data bases needed to tie in suppliers and dealers. Building and maintaining complex, accurate data bases is one of EDS' major strengths and will provide the means to integrate all segments of the manufacturing process. The dealers are being given direct electronic data communications with GM's computers, which will greatly speed up order taking and production scheduling. EDS will have great potential for commercializing this manufacturing systems integration expertise once the company can show off a few automated GM factories.

d. Recent Activities

Besides manufacturing systems, EDS is building GM its own private communications network to expand communications capacity and reduce the cost of voice, video, graphics, and data exchange. This will provide new capabilities to enhance segments of the manufacturing information system.

7. MSA/Comserv

a. Products/Services

MSA has acquired Comserv, and now markets their AMAPS product line, a comprehensive set of closed-loop MRP II applications software products plus related shop floor control and CAD applications. MSA also offers its own MRP II software package.

b. Markets Served

MSA's MRP II system is targeted to very large ($100 million or more) discrete and process manufacturers using IBM mainframes. Comserv's products are complementary to MSA's, being targeted to manufacturing companies with at least $60 million in annual sales, using IBM mainframes, plus smaller and/or decentralized manufacturing firms using HP 3000 minicomputers. Comserv's AMAPS/G is targeted at manufacturing firms who pursue government contracts.

c. Company Strategy

MSA's acquisition of Comserv will accelerate MSA's penetration of the manufacturing systems market, which is a strategic objective for MSA.

MSA benefits from excellent name recognition and size, with a large user base and enough revenues available to sustain a successful sales and support force.

MSA has strongly endorsed IBM's DB2 as their standard data base management system.

d. Recent Activity

With the Comserv acquisition, MSA has over 3,000 installations in manufacturing companies.

MSA is moving to enter the mid-range market with IBM 36/38-based manufacturing software.

MSA has jointly conducted manufacturing seminars with Arthur Anderson.

e. Future Directions

MSA's fourth generation language, Information Expert, will be a vehicle for integrating and customizing manufacturing applications. These fully-integrated systems provide MSA with a vehicle for entry into the CIM arena.

8. Intergraph

a. Products/Services

CAD/CAE/CAM graphics and DBMS systems.

Prices range from $40,000 to $680,000.

b. Markets Served

Deliver turnkey systems based on Digital's M-VAX to 8600 systems; 2,300 systems are installed.

c. Recent Activity

Microprocessors are reducing prices of "per-seat" systems. Intergraph has taken advantage of this trend by introducing four workstation systems based on DEC microprocessor technology.

9. Boeing Computer Services

a. Products/Services

Production Management System (PMS), Maintenance and Materials Management (MMS).

b. Markets Served

Discrete and process manufacturing software for HP 3000 systems, IBM mainframes. Overall, BCS has 1,200 customers. Nearly 50% of revenue came from federal government contracts.

c. Company Strategy

Boeing is a well-recognized name, providing various forms of remote computing services, facilities management, and software products. Major industry markets are services to the federal government, engineering, and energy sectors. Future markets for BCS services will emphasize telecommunications, manufacturing, and distribution.

d. Recent Activities

Boeing Network Architecture (BNA) is Boeing's architecture for systems within which the Technical and Office Protocol (TOP) has been linked with products from the Manufacturing Automation Protocol (MAP). MAP was demonstrated in model form in November 1985 at the Autofact Conference.

e. Future Directions

Boeing will continue to develop capabilities in the manufacturing sector and will have the resources and technical know-how to be a major competitor. Boeing will expand its products and presence with leverage from manufacturing systems developed for Boeing aircraft design and manufacture.

10. Martin Marietta Data Systems (MMDS)

a. Products/Services

The MAS system incorporates master scheduling, inventory control, manufacturing engineering, purchasing control, cost generation, engineering control, cost management, material lot tracking.

b. Markets Served

Products are available as a remote processing service form MMDS' four data centers; as software products for IBM, DEC and HP computers; or as

DEC VAX turnkey systems. Services are provided in the United King-
dom through Hoskyns International. Over 700 customers utilize MMDS'
MAS products.

c. Recent Activity

MMDS recently sold parts of its software business (RAMIS II and UFO)
to Online Business Systems for $35 million.

d. Future Directions

MMDS is broadening its approach to information systems, looking to be
more of a commercial systems integrator; it has already enjoyed some
successes in this area. MMDS still supports its own MAS products, but is
not reluctant to recommend other vendors' software as a part of a larger
systems integration contract.

11. American Software

a. Products/Services

Application software packages for manufacturing companies. Sixteen
software modules include: order processing, master scheduling, MRP II,
bill of material, capacity planning, shop floor control, production status,
route and work center maintenance, cost management and tracking,
purchasing, and forecasting.

b. Markets Served

IBM mainframes and System 38. American Software has 520 customers,
including 300 MRP installations.

c. Company Strategy

American Software has integrated its separate modules into a total manu-
facturing system. It expanded into the System 38 market in 1985.

12. Systems Software Associates (SSA)

a. Products/Services

MRP II software packages.

b. Markets Served

IBM System 36/38 installed base. SSA has 1,600 installations worldwide, second only to IBM in the System 36/38 market.

c. Company Strategy

Sales are made through a network of 43 affiliates, 25 in the U.S.

d. Recent Activity

SSA went public in 1987, and has used the proceeds to buy several of its affiliated companies (typically a systems software house) in Chicago, New England and Australia.

13. Cincom

a. Products/Services

Software products and services. Control/MFC includes MRP II, master production schedules, bill of materials, shop floor control, purchasing cost management and order entry. Prices vary from $21,000 to $85,000 per module.

b. Markets Served

Manufacturing installations with IBM 43XX, 30XX, DEC VAX systems.

c. Company Strategy

Cincom has committed itself to a major effort in the manufacturing systems market. Cincom currently serves more than 200 manufacturing installations.

Cincom will use its position as a vendor of systems/utility software to offer a broad system solution embedding operations and systems software. The Cincom-installed system software customer base within the manufacturing sector is a valuable prospect source.

IV

Information Systems
Department Outlook

IV

Information Systems Department Outlook

Exhibit IV-1 shows the 1987 budget distribution and projects the 1988 budget growth for IS expenses. Distribution of expenses has not changed substantially from 1986. People, communications, software, mainframe, and micro costs are up as a percent of the total budget, but only by a single percent or less. Maintenance, minicomputer, external processing, and professional services are down a small percent each. Factors influencing budget growth include:

- Upgrading of technology and capacity.
- New CIM manufacturing and on-line end-user applications.
- Inflation.
- Government tracking and control requirements.

A ten percent increase in mainframe and micro systems hardware and software reflects corporations' realization that managing information is essential to business success and that this must be done with the best IS tools available.

Communications costs continue to grow as manufacturing, sales, support, and consumers are being brought on-line to improve productivity and profits. Factors influencing budget stabilization include:

- Expense management.
- Better hardware and software price/performance.
- Productivity improvements.

EXHIBIT IV-1

DISCRETE MANUFACTURING
1987 BUDGET DISTRIBUTION AND
1987/1988 CHANGES IN THE DISCRETE MANUFACTURING SECTOR

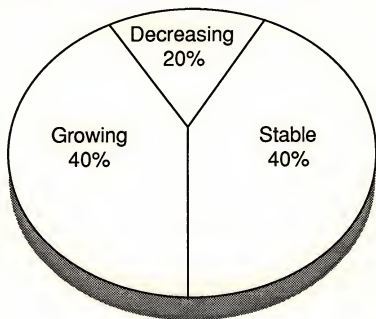| BUDGET CATEGORY	1987 PERCENT OF I.S. BUDGET (PERCENT)	1986/1987 EXPECTED BUDGET GROWTH (PERCENT)
Personnel Salaries and Fringes	46.0	6.0
Mainframe Processors	9.4	10.9
Minicomputers	3.7	6.2
Microcomputers	4.9	15.1
Mass Storage Devices	3.0	8.0
Other Hardware	3.6	3.5
Total Hardware	24.6	10.2
Data Communications	13.4	10.2
External Software	6.2	4.2
Professional Services	.5	(10.0)
Software Maintenance	2.2	3.0
Hardware Maintenance	4.6	8.8
Other	2.5	5.2
Total	100.0	7.6

Factors influencing budget decreases include:

- Revenue decrease and related expense controls.

- Continued decrease in use of outside services and consultants. This reflects a determination to keep costs down and to be self-reliant.

- Data center consolidation.

Exhibit IV-2 shows the percent of respondents expecting their budget to grow, stabilize, or downsize in 1988. The financials continue to indicate a down turn in the manufacturing sector and a strong emphasis on expense and profit management. This is reflected in a consistent movement to integrate IS as a full partner in the management of the business and to justify and approve all IS work (new hardware and applications), primarily on an ROI basis.

EXHIBIT IV-2

**DISCRETE MANUFACTURING
1987 BUDGET CHANGES
AS A PERCENT OF RESPONDENTS**

Decreasing
20%

Growing
40%

Stable
40%

Forty percent expect to see budget growth in the 12 percent range. Factors influencing budget growth include:

• Increased investment in computer manufacturing-related IS hardware and software.

• Inflation.

• Increased business revenues.

• Upgrade in hardware technology and capacity.

• Investment in end-user and consumer applications.

• Government tracking and inventory management requirements.

• Personnel expense.

Twenty percent expect serious downsizing of the IS operation and budget. Factors influencing budget decreases include:

• Consolidation of IS centers.
• Poor revenue outlook.
• Expense control.

Forty percent expect their costs to remain at the same level as this year. This implies a real decrease in expenses as they all expected inflation to raise actual costs. Factors influencing budget stabilization include:

• Business revenues stable to decreasing.
• Consolidation of data centers.
• Improving hardware and software price/performance.
• Lower and seemingly stable inflation.
• Downsizing to stay profitable.

V

New Opportunities for Clients

V

New Opportunities for Clients

This section will discuss some of the opportunities for information services vendors.

Because of its size, the manufacturing market has long been attractive for computer software and services vendors. The current size of the information services segment is approaching $6.5 billion.

Many of the opportunities in this sector are well-understood and well-defined. Among these are the traditional segments including CAE, CAD/CAM, MRP II, and inventory management and control.

The following is a discussion of significant opportunities for INPUT clients.

A
Manufacturing Planning and Control Systems (MPCS)

There is a great deal of demand for linking these "back office" systems to other functional departments. Opportunities exist for network products, database systems, systems integration, and professional services.

There is also demand to replace the older planning/control systems with more up-to-date architectures that will allow connectivity. This is the real target for applications software developed around data base systems. This is also a potential foot in the door for participating in CIM.

Electronic data interchange (EDI) is expected to be a significant opportunity for processing/network services vendors.

B

CAD/CAM/CAE

As in the manufacturing information systems area, there is an opportunity in the CAD/CAM/CAE segment to link independent systems together. In some instances this is an interface strategy; in others an integration approach is required.

Microprocessor-based CAD/CAM systems will be installed in increasing numbers as hardware prices fall and software becomes more feature-rich.

An emerging demand is in the area of computer-aided maintenance management (CAMM). This is a high-potential opportunity for both software and turnkey vendors to develop systems for analyzing and scheduling maintenance in the plant. The predictive maintenance function is a logical enhancement to complete offerings in this area.

C

Shop Floor Control

The opportunities in shop floor control tend to be greater for hardware-oriented vendors.

Because of this, information services vendors should consider joint venture relationships with hardware vendors who need applications software, installation support, and custom software development.

While opportunities seem to be available for turnkey vendors, there are associated risks due to the potential demand for customization of these highly complex processes.

D

MAP

Major systems built around and connected to MAP networks will begin coming online in the early 1990s. Vendors with MAP-compatible products will be able to participate fully in this major thrust toward CIM.

E

Computer-Integrated Manufacturing (CIM)

The moving target labeled CIM presents many opportunities supported by enormous demand that will attract the very large competitors. Most information services vendors should develop strategies to partner with these very large vendors.

• MAP implementations using systems integration (SI) is expected to be a very large market. The practice of using SI-type procurements has been employed successfully by the federal government for a number of

years and would be a good model to emulate in the private sector. MAP activity will increase steadily over the next few years, as will the need for SI to support it.

- Expertise in any of the following CIM components would make an attractive potential partner for the strategy of teaming with one or more of the very large vendors.

  - Computer-aided design.
  - Group technology.
  - Manufacturing planning/control.
  - Automated handling systems.
  - Computer-aided manufacturing.
  - Industrial robots.
  - Processing/network integration.

Organizations possessing manufacturing systems expertise should consider leveraging these skills through professional services offerings. Since this industry displays a preference toward customization, programming services will continue to be in demand.

There are also corresponding opportunities with small- to medium-sized manufacturers where the competitive pressures may be less severe.

VI

Conclusions and Recommendations

VI

Conclusions and Recommendations

The discrete manufacturing market will continue as a large and attractive opportunity for vendors of computer-based products and services. However, the market is expected to change frequently over the next few years as new applications and new solutions emerge. Manufacturing planning/control markets are replacement-oriented at the high end, and many competitors have entered the low-end microprocessor-based market. Price competition will continue to have an impact on all vendors. Some consolidation is expected.

Clients wishing to participate in the discrete manufacturing market should begin now by developing detailed long-range plans. These plans should include, as a minimum:

- Market segmentation and identification of specific segments by type of manufacturer, by functional target, by geographic area, and by the current competitive environment.

- A thorough competitive assessment completed in order to understand who to compete with and who to team with. Potential competitive advantages and disadvantages must be identified and understood by all levels within the organization.

- A complete staff analysis performed to determine the type of staff needed, the appropriate organization required, and the sources available for staffing to meet the plan.

- A technology assessment by vendors to predict both new technology impacts and the potential timing of competitive or new technology. This

evaluation should also include an analysis of technology needed to respond to competitive threats.

- Analysis by clients of the market for potential teaming alternatives. Candidates and their perceived strategies, strengths, and weaknesses should be identified and included in the plan by the gap that candidates would fill in executing the strategic plan.

Don't be greedy. This is a very large market with many multi-million dollar opportunities.

The manufacturing industry sector has had a history of propensity to build versus buy. Vendors should expect this attitude to continue to be prevalent. For software and turnkey vendors this means a strategy that includes the ability to customize the product. Such a decision must be a conscious, not opportunistic, one.

Professional services vendors should evaluate the system integration practice in the federal government. Large, complex systems such as those expected in the manufacturing industry could benefit from this approach. A creative, proactive thrust in system integration may be a winning strategy.

INPUT's analysis concludes there will be many opportunities for vendors to "waste their time" on big deals that will never happen or whose decision cycle will be continually extended. All sales activity should be carefully monitored to determine any patterns in these procurements in order to adequately plan and deploy the sales resource.

Sales campaigns should be structured around two central themes:

- Cost reduction (this sector must be competitive to survive).
- Time savings (translates to cost and the ability to respond to competition).

DM-A

Appendix: Definitions

DM-A

Appendix: Definitions

A

**Manufacturing-
Specific Definitions**

Bill of Material (BOM) - A listing of all subassemblies, parts, and materials that go into an assembled part (showing the quantities of each).

CAD/CAM - The integrated applications of CAD and CAM.

Capacity Requirements Planning - The translation of open shop orders and planned shop orders into hours of work by time period and work center.

Computer-Aided Design (CAD) - Applications of computer and graphic technology to engineering, design, and drafting.

Computer-Aided Engineering (CAE) - Applications of computer and graphic technology to engineering, design, and drafting.

Computer-Aided Maintenance Management (CAMM) - Systems for analyzing and scheduling maintenance in manufacturing plants. The predictive maintenance function would be the next logical development.

Computer-Aided Manufacturing (CAM) - Application of computer and graphic technology to manufacturing, engineering, planning, and control.

Computer-Integrated Manufacturing (CIM) - Integration of separately automated factory functions. These functions include MRP II, CAD/CAM/CAE, DSS, process control, ATE, and robotics. CIM is very complex and should be considered as requiring management change to commit to the technology and philosophy.

Electronic Data/Document Interchange (EDI) - The use of a communications network to transmit and receive electronic business transactions between multiple locations on an intra- or inter-company basis.

Finite Element Analysis - As used in this report, includes all tasks involved in structural analysis using finite element methods–mesh generation, preprocessing, finite element analysis processing, and post-processing.

Group Technology - the application of classification and coding technology to search a data base for information on similar parts and to apply this to CAD and CAM tasks.

Manufacturing Resource Planning II - an extension of MRP, where MRP is integrated with financial planning, a simulation capability, and other functions on a closed-loop basis for the planning.

Master Production Schedule - An anticipated build schedule that drives the MRP systems.

Material Requirements Planning (MRP) - A system to calculate material requirements on a dynamic basis using inputs from BOM, inventory status, open order status, and master production schedules.

Nesting - Software to automatically or interactively arrange patterns for parts within stock material boundaries.

Numerical Control (NC) - CAM technology and systems for generating numerically-controlled machine tool programs.

Shipments - The dollar equivalent of products shipped by a manufacturing establishment. Will usually be approximately equal to annual revenue.

Shop Floor Control - Control of the progress of each customer order or stock order through the operations of its production cycle and the collection of data about actual completion results or status.

Value Added - The portion of product shipment values originating in that industry; includes factors such as labor costs, depreciation, various business expenses, and energy costs. It is basically the difference between shipments and raw or input materials costs.

B

Other Definitions

Database Management System (DBMS) - A software system that allows a user to structure a data base by defining the data, its organization, and the association between data elements. It also includes a data manipulation language (for accessing, sorting, merging, etc.) and controls for concurrent use (security, request, queuing, etc.) Functions as a common interface to multiple applications.

Distributed Data Base - A data base that is physically located at multiple sites, with each site having a part of the total data base. The sites are usually linked to a central site and have access to each other.

Distributed Processing - Multiple computers simultaneously processing elements of a CAD or CAM task.

Management Information System (MIS) - A data processing system specifically designed to provide business managers with company, financial, project, or program data.

Networking - The interconnection and control of remotely located systems and devices over communications lines.

DM-B

Appendix: Forecast Data Base: Discrete Manufacturing Sector

DM-B

Appendix: Forecast Database: Discrete Manufacturing Sector

This appendix contains the following forecast information, as shown in Exhibits DM-B-1 and DM-B-2.

- Market size by delivery mode for each year, 1986-1992.

- Market growth rates for 1986-1987.

- Average annual growth rate (AAGR) for each delivery mode for the five-year period 1987-1992.

- Market size by product category for each year, 1986-1992.

  - Manufacturing Planning and Control Systems
  - CAD/CAE/CAM

- Market growth rates by product category.

- Average annual growth rate (AAGR) by product category, 1987-1992.

EXHIBIT B-1

DISCRETE MANUFACTURING INDUSTRY SECTOR
INDUSTRY-SPECIFIC USER EXPENDITURE FORECAST,
1986-1992

SEGMENTATION BY DELIVERY MODE	1986 ($M)	1986-1987 Growth (%)	1987 ($M)	1988 ($M)	1989 ($M)	1990 ($M)	1991 ($M)	1992 ($M)	AAGR 1987-1992 (%)
Processing/ Neworks Services									
Remote Computing/ Batch	631	15	726	828	935	1,047	1,163	1,279	12
Facility Management	52	13	59	67	75	85	96	107	13
Total Processing Services	683	15	785	895	1,010	1,132	1,259	1,386	12
Application Software									
Mainframe/Mini	857	18	1,011	1,183	1,372	1,578	1,799	2,033	15
Micro	98	73	170	255	332	398	458	519	25
Total Application Software	955	24	1,181	1,438	1,704	1,976	2,257	2,552	17
Turnkey Systems	1,662	12	1,861	2,066	2,272	2,499	2,749	2,997	10
Sector Product Total	3,300	16	3,827	4,399	4,986	5,607	6,265	6,935	13
Professional Services	1,988	30	2,587	3,138	3,790	4,468	5,417	6,593	21
Total	5,288	21	6,414	7,537	8,776	10,075	11,682	13,528	16

EXHIBI BI-2

DISCRETE MANUFACTURING INDUSTRY SECTOR
INDUSTRY-SPECIFIC
USER EXPENDITURES FORECASTS, 1986-1992
BY PRODUCT CATEGORY

PRODUCT CATEGORY	1986 ($M)	1986-1987 Growth	1987 ($M)	1988 ($M)	1989 ($M)	1990 ($M)	1991 ($M)	1992 ($M)	AAGR 1987-1992 (%)
Manufacturing Planning and Control Systems (MPCS)	1,503	13	1,698	1,868	2,055	2,260	2,486	2,735	10
Design and Fabrication Systems (CAD/CAM/CAE/NC)	1,797	18	2,129	2,531	2,931	3,347	3,779	4,200	15
Product Total	3,300	16	3,827	4,399	4,986	5,607	6,265	6,935	13

About INPUT

INPUT provides planning information, analysis and recommendations to managers and executives in the information processing industries. Through market research, technology forecasting, and competitive analysis, INPUT supports client management in making informed decisions. Continuing services are provided to users and vendors of computers, communications, and office products and services.

The company carries out continuous and in-depth research. Working closely with clients on important issues, INPUT's staff members analyze and interpret the research data, then develop recommendations and innovative ideas to meet clients' needs. Clients receive reports, presentations, access to data on which analyses are based, and continuous consulting.

Many of INPUT's professional staff members have nearly 20 years experience in their areas of specialization. Most have held senior management positions in operations, marketing, or planning. This expertise enables INPUT to supply practical solutions to complex business problems.

Formed in 1974, INPUT has become a leading international planning services firm. Clients include over 100 of the world's largest and most technically advanced companies.

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